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ABSTRACT

This teacher's guide contains information, lesson plans, and diverse student learning activities focusing on aviation. The guide is divided into seven sections: (1) "Drawing Activities" (Airmail Art; Eyewitness; Kite Power); (2) "Geography" (U.S. Airports); (3) "Information" (Aviation Alphabet; Glossary; Four Forces of Flight; What about Wind?; Kid's History of Flight; Educator's History of Flight); (4) "Language Arts" (Flying ABCs; Aviation Poetry; Something's Wrong; Aerial Jumble; Scrambled; Balloon Scramble); (5) "Lesson Plans" (In Aviation News; The Bubble Classroom; Airmail); (6) "Math" (Airport Math; Up, Up, and Away); and (7) "Puzzles" (Kite Word Search/Riddle; Balloon Maze; Hot Air Balloon Word Scramble/Crossword; Flying Match). (BT)

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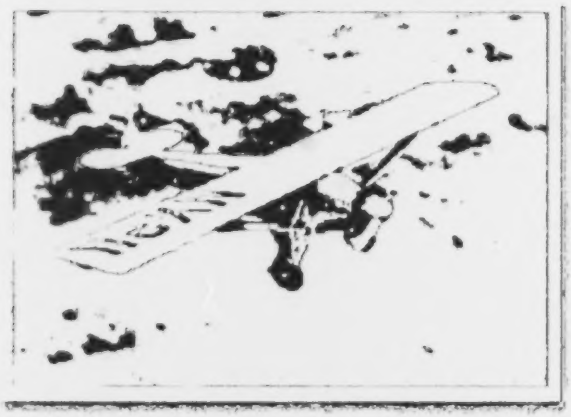
Teacher Resources

Aviation



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AIRMAIL ART

The United States government began the world's first regular airmail service in 1918. When people sent letters by airmail, they had to have a special stamp. Because so many letters travel by plane now, we don't use airmail stamps anymore unless we're sending a letter to another country. Draw a special airmail stamp that shows an important event in aviation history.

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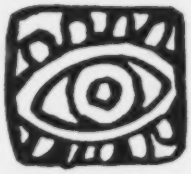
EYEWITNESS

Imagine you are at an important event in aviation history (Charles Lindbergh's landing at Paris in 1927 or the Wright Brothers' first flight at Kitty Hawk in 1903, for example). You want to remember the day forever, but you forgot your camera. Draw a picture of what you saw and give it a title so you can remember the event.



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Kite Power!

For thousands of years, kites have been used for many different reasons. Some of the ways they have been used are: to catch fish, lift up people, scare away birds, conduct experiments, celebrate events, and to power vehicles. Design your own kite invention below.

How does it work? Who would use it?

U.S. AIRPORTS

Each airport in the United States has an identification code. These codes are used on your airline ticket and baggage claim check. Some of these airport codes are listed below. Notice that the airport may be named after the city (such as Los Angeles International) or named after a person (such as San Diego's Lindbergh Field).

SAN—San Diego, California (Lindbergh Field)

LAX—Los Angeles, California (Los Angeles International)

BNA—Nashville, Tennessee (Nashville International)

ORD—Chicago, Illinois (O'Hare International)

IND—Indianapolis, Indiana (Indianapolis International)

BOS—Boston, Massachusetts (General E.L. Logan International)

STL—St. Louis, Missouri (Lambert International)

MIA—Miami, Florida (Miami International)

MSY—New Orleans, Louisiana (Moisant Field)

DFW—Dallas/Ft. Worth, Texas (Dallas/Ft. Worth International)

MKE—Milwaukee, Wisconsin (General Mitchell Field)

DIA—Denver, Colorado (Denver International)

SEA—Seattle, Washington (Seattle/Tacoma International)

LNK—Lincoln, Nebraska (Lincoln Municipal)

MSP—Minneapolis/St. Paul, Minnesota (Minneapolis/St. Paul International)

Find each city on the map and label it with its airport code.

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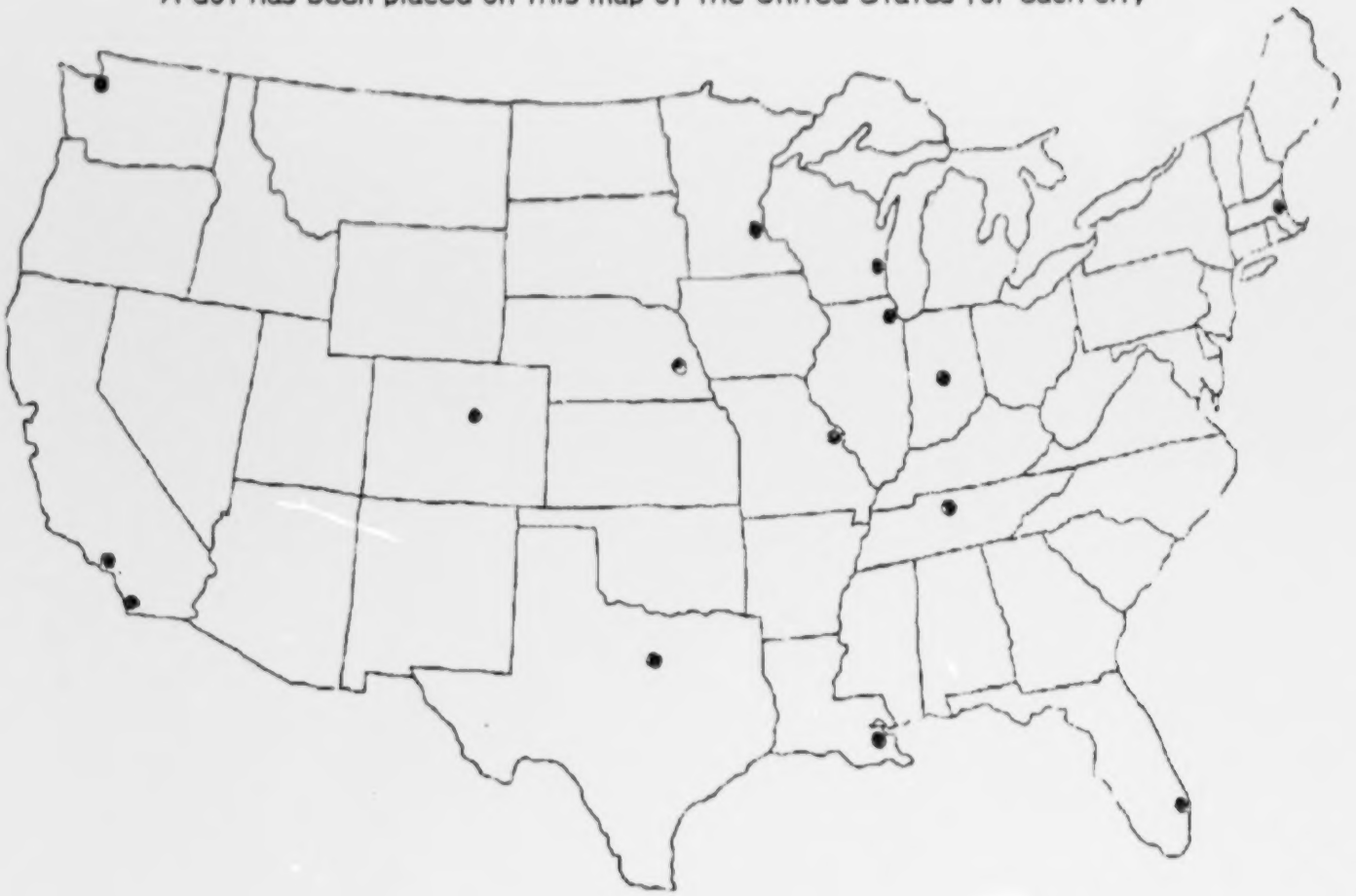
U.S. AIRPORTS

A dot has been placed on this map of the United States for each city



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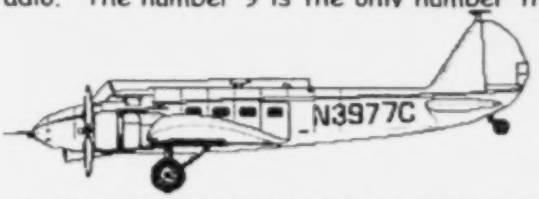
AVIATION ALPHABET

When pilots talk on the radio, they want to make sure their message is understood. Because some letters of the alphabet sound the same (such as M and N or B, C, D, E, G, P, T and V), they sometimes use this "aviation alphabet" to make sure the person to whom they are talking hears them correctly. The pilot of the Boeing 247 pictured here, for instance, would call the control tower at San Diego's Lindbergh Field by saying "Lindbergh tower, this is November-Three-Niner-Seven-Seven-Charlie." Notice the pilot said "niner" instead of "nine." Pilots do this because "nine" might sound like "five" over the radio. The number 9 is the only number that is spoken differently.



"...NOVEMBER-THREE-NINER-SEVEN-SEVEN-CHARLIE."

A	Alpha	N	November
B	Bravo	O	Oscar
C	Charlie	P	Papa
D	Delta	Q	Quebec
E	Echo	R	Romeo
F	Foxtrot	S	Sierra
G	Golf	T	Tango
H	Hotel	U	Uniform
I	India	V	Victor
J	Juliet	W	Whiskey
K	Kilo	X	X-Ray
L	Lima	Y	Yankee
M	Mike	Z	Zulu

- Can you spell your name using the aviation alphabet? Try a friend's name.
- Write a short sentence using the aviation alphabet, then read it to a partner. See if your partner can understand what you are saying.

Example: "I am hungry": India Alpha-Mike Hotel-Uniform-November-Golf-Romeo-Yankee.

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Glossary

AILERON : a hinged flap on a wing for controlling a banked turn. (Turning with one wing up and the other down.)

AIRCRAFT: any flying machine: an airplane, airship, glider, kite, or helicopter.

AIRFOIL: a body that has a special shape that converts moving air to lift (like an airplane wing).

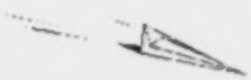
AXES OF ROTATION: the three imaginary lines that pass through a kite's center of gravity at right angles to each other. All movements a kite makes can be can be defined in terms of these lines. (See PITCH, YAW, and ROLL).

BRIDLE: a bridle connects the flying line to the kite, at the TOW POINT, and sets the angle of the kite to the wind (called the ANGLE OF ATTACK). A bridle can have two or more LEGS. Some kites have a single tow point and no bridle.

CONTROL SURFACES : the parts of an airplane or glider that a pilot moves to control the flight (See AILERON, ELEVATOR, and RUDDER.)

DRAG: the total air resistance to the flight of an aircraft. The rougher the surface of an airfoil, the more drag; the more streamlined an airfoil, the less drag.

ELEVATOR: the flap on an airplane's tail that controls diving and climbing.



FACE: the front surface of a kite.

FRAME (BONES): the combination of a kite's struts and spine.

FUSELAGE : the main body of an airplane

GRAVITY (WEIGHT): the downward pull on an object.

LEADING EDGE: the forward edge of an airfoil as it moves forward.

LIFT: the upward force acting against a aircraft as the result of it deflecting the wind. The force of lift opposes the forces of drag and gravity.

NOSE (TOP): the top end of a kite.

PITCH : to rotate about the lateral axis; to tip up or down.

ROLL: to rotate about the longitudinal axis; to rock sideways.

RUDDER: A control surface on an airplane or glider's tail for turning left or right.

SAIL (SKIN): the kite covering.

SPINE: the back bone or central strut of a kite.

STABILITY: the ability to return to a normal flight path after being disturbed.

STALL: occurs when an aircraft loses forward speed and stops in the air.

STRUTS: the side and cross sticks that are used to give shape to the kite.

TAIL: something that attaches to the bottom of a kite to add stability by creating drag (NOT WEIGHT). Or, the back end of an airplane or glider.

THRUST: comes from an energy source (like wind). There has to be enough thrust to overcome gravity and drag for an aircraft to fly.

TOW POINT: where a kite's flying line connects to its BRIDLE.

TRAILING EDGE: the rear edge of an airfoil as it moves forward.

TRAIN: a series of kites flown on a common line or lines.

VENT: an opening for the passage of wind; aids stability.

WINDER (REEL): carries the flying line.

YAW: to rotate about the vertical axis; to turn to the right or left.

The Four Forces of Flight

LIFT is created when air flows over an airfoil. (Bird wings, kites, frisbees, and airplane wings are all airfoils.) When enough air is moving fast enough, the force of LIFT can become stronger than the force of gravity.

Lift

DRAG is caused by air pushing against the aircraft. An airplane's flaps and landing gear help create DRAG when it is slowing down to land.

Thrust

Drag

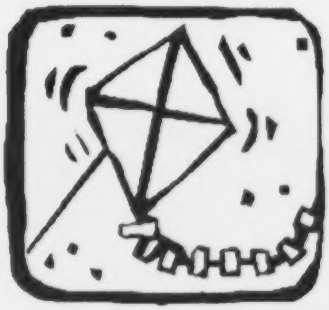
Without THRUST, there is no moving forward. In airplanes, THRUST might come from jet engines or propellers. If it is a paper airplane, the THRUST comes from your hand.

Gravity

!f you don't know what GRAVITY is, try jumping up without coming back down. Aha! GRAVITY!

What About Wind?

M.P.H.	Characteristics	Name
1-3	smoke drifts	CALM
4-7	leaves rustle	LIGHT
8-12	leaves dance	GENTLE
13-18	trees toss, dust flies	MODERATE
19-24	small trees sway	FRESH
25-31	large branches sway	STRONG



Material	Wind Needed(M.P.H.)
Light paper	4-12
Light plastic	4-18
Heavy plastic	13-31
Light cloth	4-31
Sturdy cloth	13-31

Kite Type	Wind Needed (M.P.H.)
Sled	4-18
Diamond	4-18
Delta	4-12
Box	10-31
Fighter	4-12

Problem Solving:

If your kite spins, and the wind is not too strong

- **add a longer tail**
- **check that the struts are equal lengths**
- **move the tow point back, towards the kite**

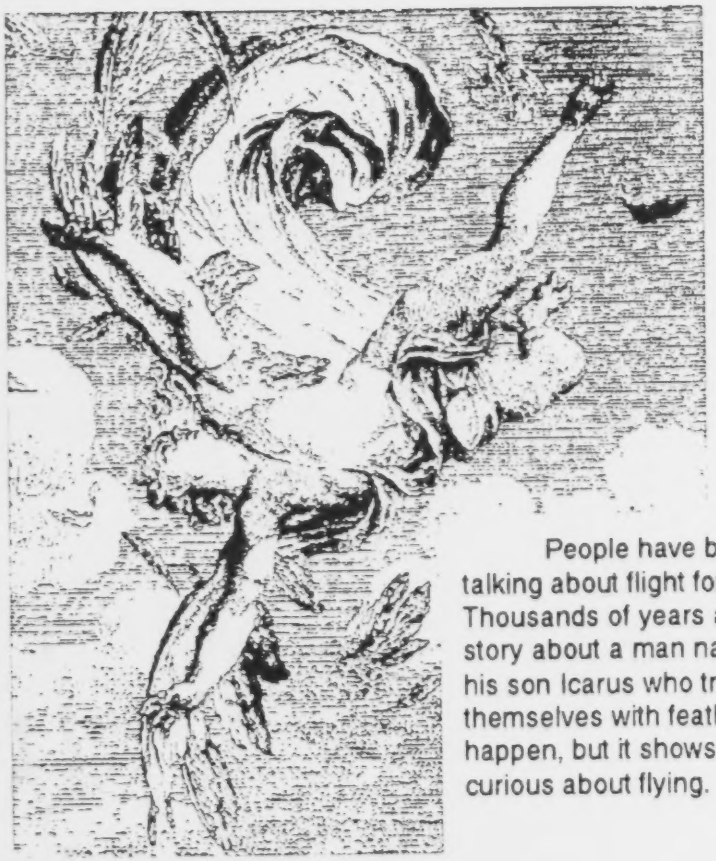
If the kite doesn't launch, and the wind is strong enough

- **replace or remove part of the tail**
- **move the tow point forward**

If the kite pulls to one side

- **move the tow point forward**
- **tape a piece of tail to the opposite side**

Kids' History of Flight



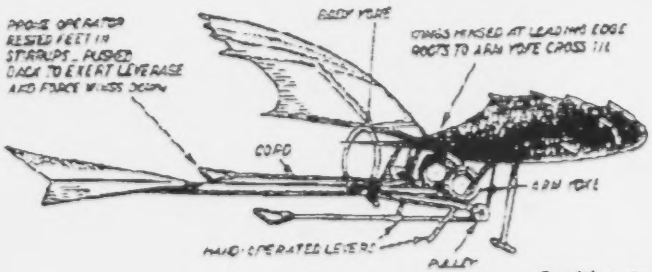
Icarus, over 2000 years ago

People have been thinking and talking about flight for a long time. Thousands of years ago, the Greeks told a story about a man named Daedalus and his son Icarus who tried to fly by covering themselves with feathers. It didn't actually happen, but it shows us that people were curious about flying.

Montgolfier Balloon, 1783

In 1782 and 1783 the Montgolfiers, two French brothers, built the first successful flying machine- a hot air balloon. A duck, a sheep and a rooster were the first passengers. After that, two men flew above Paris in the Montgolfier balloon for 25 minutes. They were the first people to experience flight.

About 500 years ago, an artist and philosopher named Leonardo Da Vinci scientifically studied how things fly. He was the first person we know of who did this. He made sketches of a flying machine called an ornithopter (which means "bird-machine"). The machine was a set of wings that a man would tie to his arms and legs. Da Vinci believed that when a person wearing the wings flapped his arms and legs, he would fly like a bird. Da Vinci never built an ornithopter, but if he had, it would not have worked. People cannot fly like birds because we are too heavy and our muscles are not strong enough to lift us in the air.



Ornithopter, 1490

500 BCE
The Icarus myth is first told

1490
DaVinci studies flight, sketches design ideas

1783
The first humans fly-in the Montgolfier's balloon

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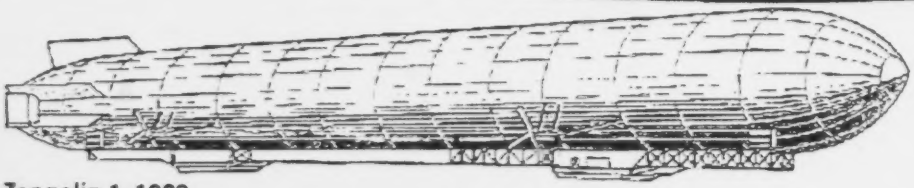
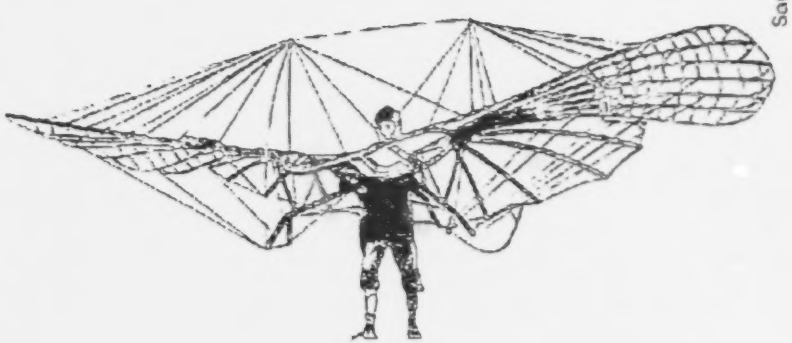
One problem with balloons is that they cannot be steered. The balloon just floats whichever way the wind blows. This makes flying a balloon from one place to another very difficult. Count Ferdinand von Zeppelin of Germany worked to change this. In 1900, he completed a dirigible that a pilot could steer. It had an engine and controls that allowed it to turn. These dirigibles became known as zeppelins and were a popular way to travel. The German army also used zeppelins to drop bombs on their enemies during World War I (1914-1918). Unfortunately, the hydrogen gas the zeppelins were filled with made them very flammable. When the zeppelin *Hindenburg* exploded in New Jersey in 1937, it killed 36 of the 97 passengers. After this disaster, no more zeppelins were built. Now, blimps use helium, which is much safer.



Zeppelin 1, 1900



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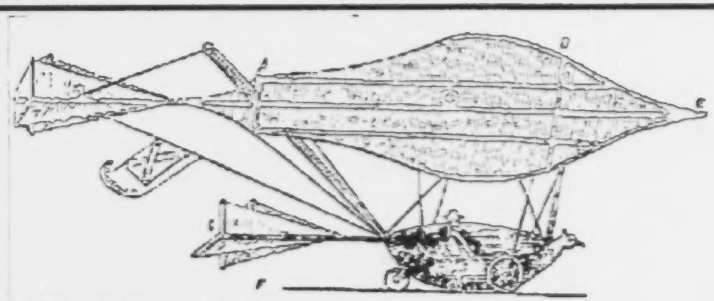
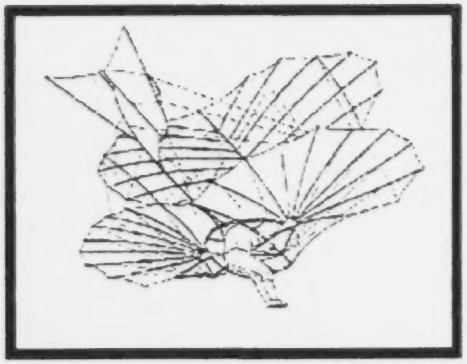


Cayley Gliders, 1800-1850

While some people were working on hot-air balloons and dirigibles, other people were interested in winged aircraft. An Englishman named Sir George Cayley built and flew gliders between 1800 and the 1850s. In 1853 Cayley's coachman became the first person to fly in a heavier-than-air machine.



Later, Otto Lilienthal, from Germany, built gliders with curved wings. His looked more like modern hang gliders, and they were steered by leaning. He flew his gliders more than 2,500 times. Many people who were interested in flight studied his notes and drawings.

1800-1850
Cayley designs and builds gliders

1890s
Lilienthal tests his own glider designs

1900
Zeppelin develops steerable dirigible

Orville and Wilbur Wright took the next big step in aviation. They owned a bicycle-repair shop in Dayton, Ohio, but they liked to think about and build flying machines. In 1900 they began flying gliders. They improved the design so that a pilot could steer by warping (bending) the wing instead of by leaning. They also added rudders and elevators to control up-and-down and side-to-side motion.

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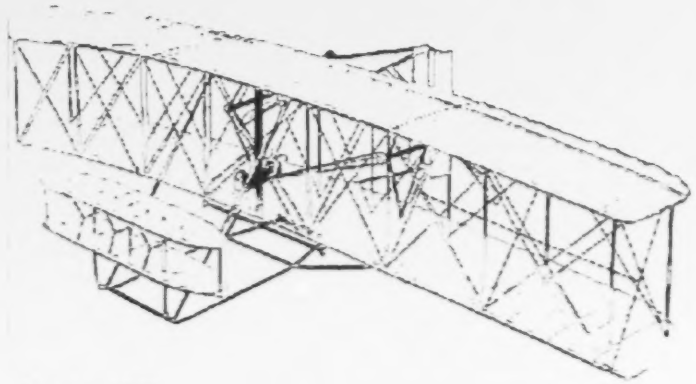

Flyer 1, 1903

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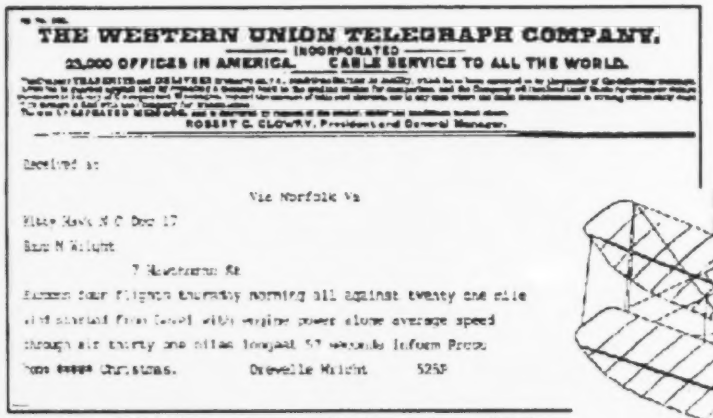
In 1903, the Wrights took their newest machine, the Flyer, to Kitty Hawk, North Carolina. It had the same basic design as their glider, but they had added an engine and propellers. On December 17, 1903, the Wrights made history when they flew the Flyer.

They had finally solved the problems of powering and controlling an aircraft. Their first flight lasted 10 seconds and went about 120 feet. Their fourth flight lasted almost a minute and went 852 feet. This was a major success, but the Wrights and their Flyer did not become famous until 1908, when they flew for people all over America and France.



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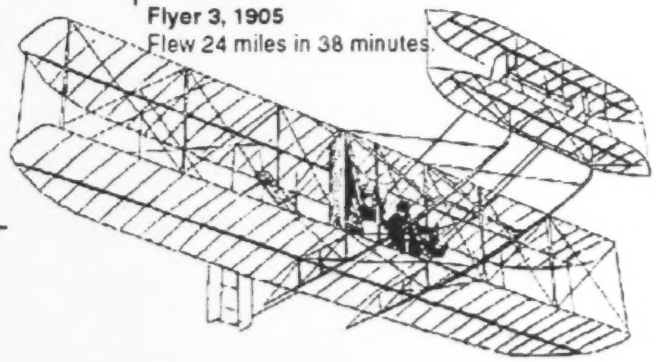
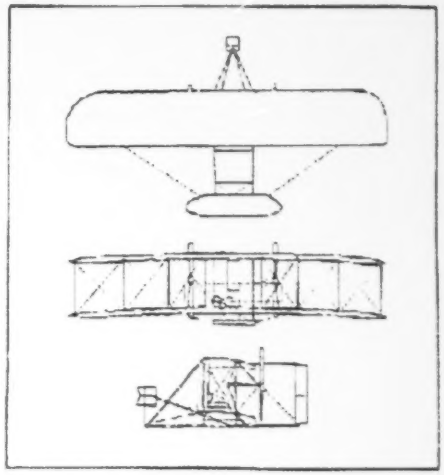
through air thirty one miles longest 57 seconds Inform Press
Home Christmas. Orevelle Wright 525P

Dec. 17, 1903 telegraph from Orville (misspelled) to his father, reporting their success



Flyer 3, 1905
Flew 24 miles in 38 minutes.



Flyer 1, 1903

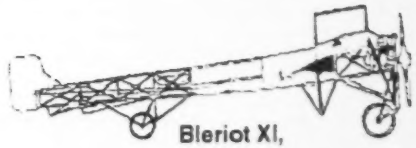
1899
Wilbur writes to the Smithsonian for information about flight research

1900
The Wrights fly their first gliders at Kitty Hawk

1901
Wrights build a wind tunnel to test wing shapes

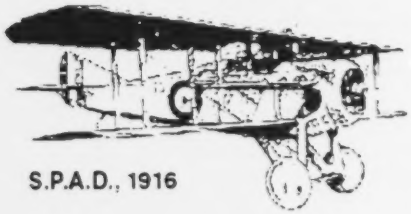
1903
Orville pilots the 1st powered aircraft

Now that powered, controlled flight was possible, many things started happening. In 1909 .ouis Bleriot flew his airplane across the English Channel- the first flight across a body of water or rom one country to another. That same year, Madame la Baronne de Larouche, also from France, ›ecame the first licensed woman pilot. The first U.S. Army airplane was built in 1909, and two years ater, Glenn Curtiss began naval aviation when he flew his first seaplane in San Diego.

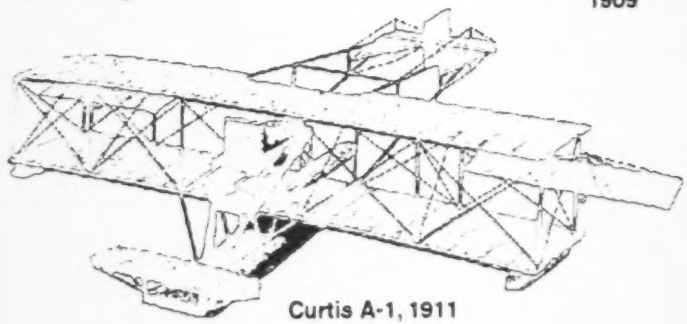


Bleriot XI, 1909

World War I caused many changes in aviation use and technology. Early in the war, armies used planes to watch each other. When machine guns were added to the planes, though, people began using them to fight other planes. Planes were also improved to become faster, larger, and able to carry bombs.



S.P.A.D., 1916



Curtis A-1, 1911

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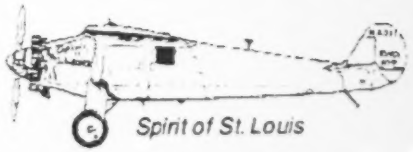
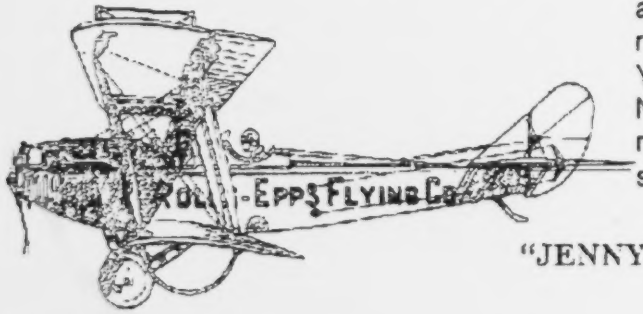


Spirit of St. Louis

In May of 1918, the U.S. started the first year-round, regularly scheduled airmail service in the world. The first route ran between Washington, D.C. and New York City. After World War I ended in November of 1918, the Post Office used many extra Army aircraft to expand airmail service across the country.

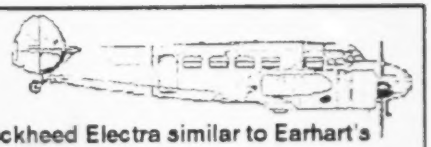
In 1927, Charles Lindbergh became the first person to fly a non-stop solo flight across the Atlantic Ocean from New York to Paris. He left New York on May 20, 1927, in his plane the *Spirit of St. Louis*. 33 hours and 30 minutes later, he landed in Paris. He became an international hero overnight.



"JENNY"

Curtiss JN-4D, 1918

In 1932, Amelia Earhart became the first woman pilot to cross the Atlantic Ocean alone, and in 1935 she was the first person to fly solo from Hawaii to California. While flying around the world in 1937, she and her navigator disappeared. Nobody knows what happened.



Lockheed Electra similar to Earhart's

1909 Bleriot crosses the Channel/ First female pilot licensed/ First U.S. Army plane built

1911 1st seaplane flies in S.D.

1914 World War 1 starts

1918 U.S. Airmail starts/ World War 1 ends

1927 Lindbergh flies the Atlantic solo, non-stop

1932 Earhart flies the Atlantic solo, non-stop

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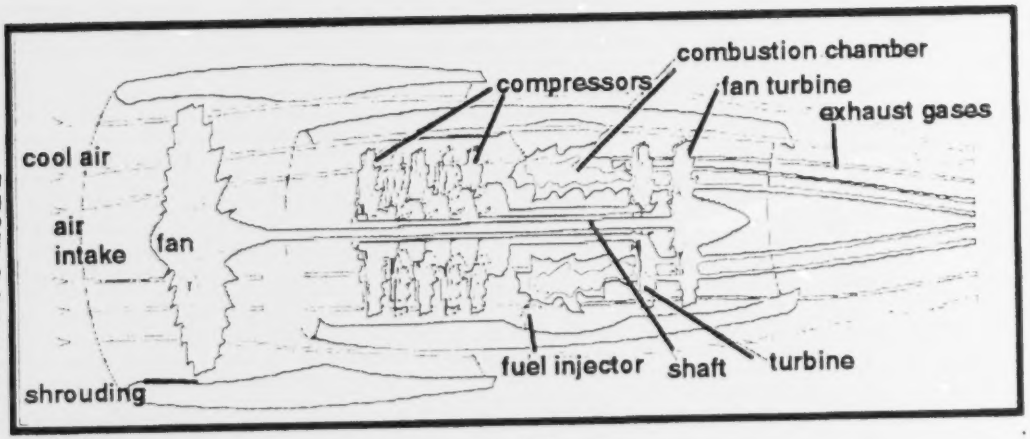
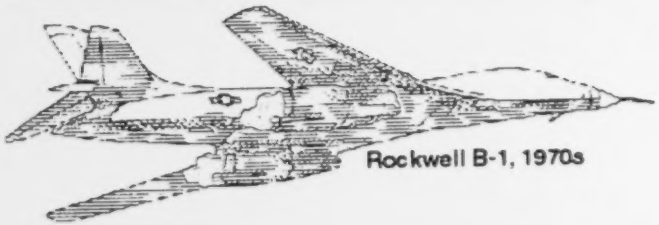


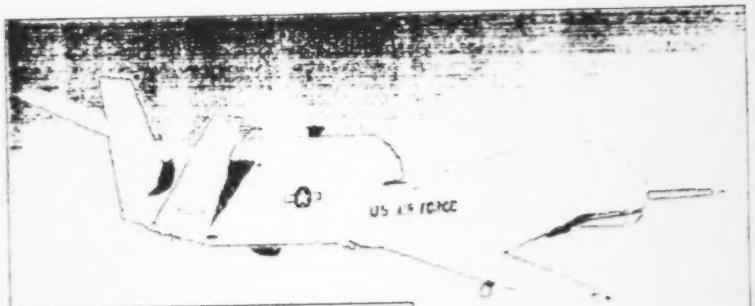
Turbofan

After World War II, the development of jet engines led to some of the biggest changes in aircraft.

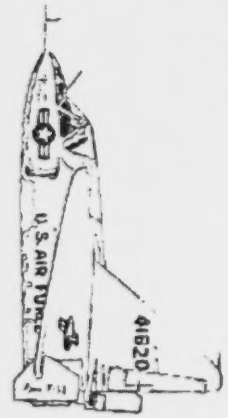
In jet engines, fans force air into a high pressure area where it mixes with fuel and ignites. The air expands and blows out the back, forcing the jet forward. (Like blowing up a balloon and letting it go.) Sometimes the exhaust is also used to turn turbines as it blows by. These turbines can power parts of the engine.



Rockwell B-1, 1970s



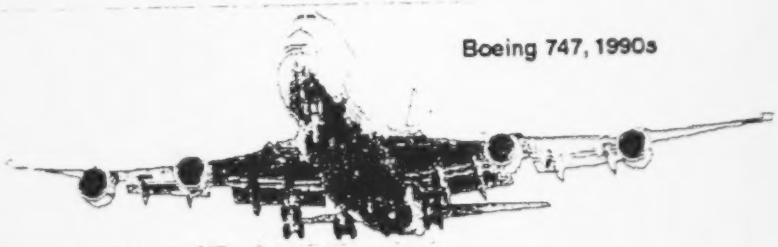
Teledyne Ryan Global Hawk, 2002



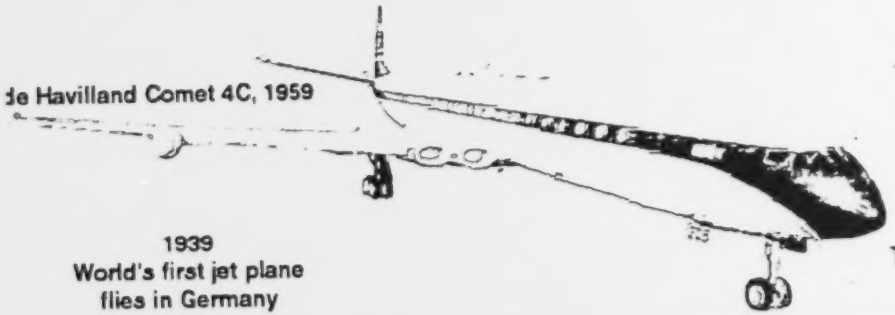
Ryan X-13 Vertijet, 1955

Before jets, a very fast plane could go about 500 miles an hour. Now, the fastest jet (the SR-71 Blackbird) travels at 2,275 m.p.h.

With jets, the military was able to try experiments like vertical take off with the Ryan X-13, and travelers are able to take long trips by plane instead of by boat.



Boeing 747, 1990s



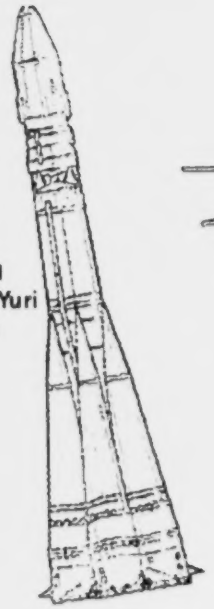
de Havilland Comet 4C, 1959

San Diego Aerospace Museum

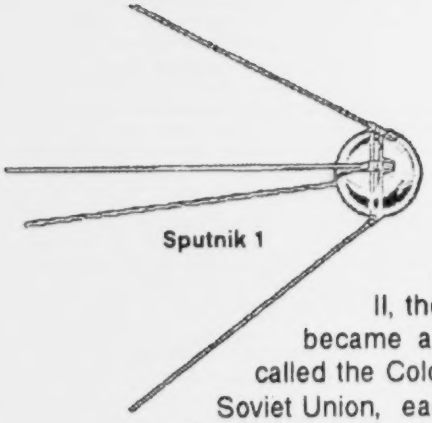
1939
World's first jet plane flies in Germany

1947
Test pilot Chuck Yeager flies faster than the speed of sound

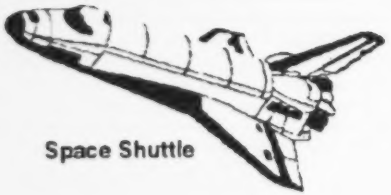
1952
1st jet airline passengers fly from England to South Africa twice as fast as before.



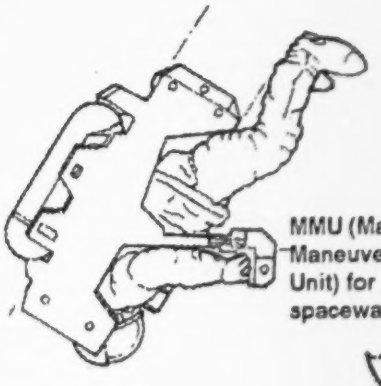
Vostok 1
Carried Yuri
Gagarin



Sputnik 1



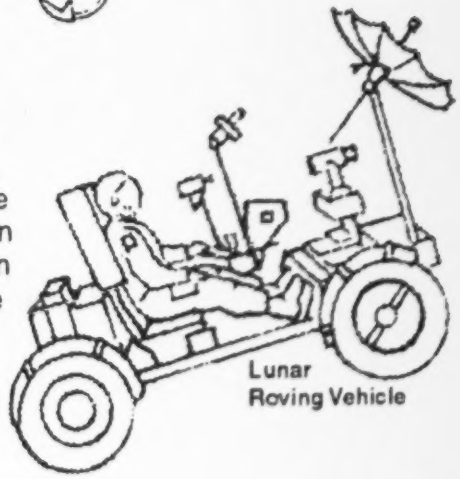
Space Shuttle



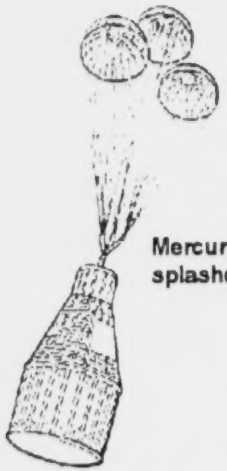
MMU (Manned
Maneuvering
Unit) for
spacewalks

San Diego Aerospace Museum

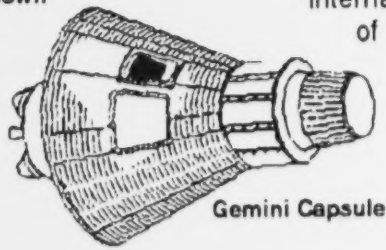
After World War II, the dream of space flight became a reality. During a conflict called the Cold War, between the U.S. and the Soviet Union, each country wanted to be the first to travel to space. (This competition was called the "Space Race.") The Soviets led the race in 1957 when they launched the first satellite, Sputnik. In 1959, they launched Luna 3, the first spacecraft to orbit the moon. Soviet Cosmonaut Yuri Gagarin became the first human in space in 1961. The U.S. was not far behind the USSR. During the 1960s, the National Aeronautics and Space Administration (NASA) worked on three different projects. Project Mercury put Americans into space. In Project Gemini, Americans started to do spacewalks and practice connecting spacecraft while in orbit. Project Apollo put Americans on the moon in 1969. During the 1970s, 1980s, and 1990s, NASA worked with space shuttles. Today, the U.S., the former Soviet Union, and other countries are working together to build the International Space Station. This is an example of how the possibilities and science of flight continue to grow.



Lunar
Roving Vehicle



Mercury Capsule at
splashdown



Gemini Capsule

Saturn V rocket with
Apollo spacecraft

1957 Sputnik launched, orbits Earth

1959 Luna 3 orbits moon

April 1961 Gagarin is 1st human in space

May 1961 Alan Shepard is 1st American in space

1965 Gemini 4 astronauts do 1st American spacewalk

1969 Apollo 11 astronauts are first humans to walk on moon

1981 1st Space Shuttle flight

1998 Construction of International Space Station begins

2006 International Space Station scheduled to be complete

A BRIEF HISTORY OF FLIGHT

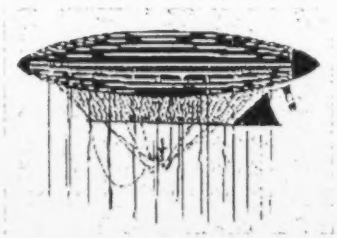
BACKGROUND INFORMATION FOR EDUCATORS

The idea of flight has fascinated people since the dawn of history. From the Greek legend of Daedalus and Icarus to space station Mir, people have been discussing, analyzing, attempting and achieving flight. Though technology has advanced dramatically, the dream of progress still remains.

While perhaps more famous for his artworks, Leonardo da Vinci was the first to make a scientific study of flight mechanics. In the late 15th century, he made sketches of a flying machine called an ornithopter, which had wings that would flap when the "pilot" moved his arms and legs. The basic principle was to enable a man to fly like a bird. Da Vinci never actually built an ornithopter, but if he had, it would not have worked: humans simply do not have the strength to lift their weight by flapping a pair of strapped-on wings.

Montgolfier balloon

The first successful flying machines were hot-air balloons built by the French Montgolfier brothers beginning in 1782. Their balloons flew when a fire was used to heat the air inside them. A duck, a sheep and a rooster were the first passengers, but in November of 1783, two men floated over Paris for 25 minutes and became the first humans to experience free flight.



Giffard dirigible

Although balloons put people in the air, they allowed little directional control; the development of airships, or dirigibles, addressed this problem. The first successful dirigible, built in 1852 by Henri Giffard, was shaped like a cigar and used hydrogen to create lift. It had a steam engine that turned a propeller and used rudders to control its direction. The LaFrance airship, built in 1884 by Charles Renard and A.C. Krebs, was the first airship that could be steered in any direction regardless of the wind.

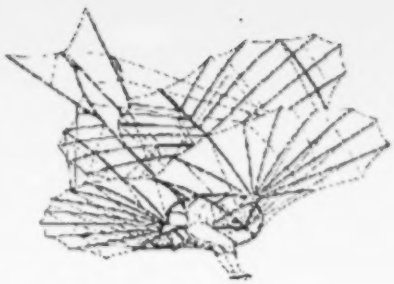
Count Ferdinand von Zeppelin of Germany perfected the rigid dirigible at the turn of the 20th century. During World War I, Zeppelins and other airships dropped bombs over London. Both before and after the war, they enjoyed success as commercial passenger carriers. The *Hindenburg*, the largest and most famous Zeppelin, exploded on May 6, 1937, while trying to land in New Jersey. Thirty-six of the ninety-seven people on board died in the accident, and this catastrophe marked the end of the dirigible as a commercial mode of transport.

Graf Zeppelin, 1928

As Giffard, Zeppelin, and their counterparts experimented with airships, other men concentrated on winged aircraft. Sir George Cayley, often called the father of modern aerodynamics, discovered the principles of flight that govern the operation of aircraft. He applied his research to a series of gliders he designed during the first half of the 19th century. In 1853 Cayley's coachman became the first man to fly in a heavier-than-air machine, albeit primarily as a passenger—the glider had few provisions for directional control. In addition to his groundbreaking discoveries in aerodynamics, Cayley also contributed significantly to the

Cayley glider

advancement of aviation by writing and publishing extensively on his research.



Lilienthal glider

Otto Lilienthal, a German, built gliders with a rigid framework that gave their fabric-covered wings a curved upper surface. This enabled them to develop lift more effectively than Cayley's all-fabric wings, which relied on air pressure to create their curvature. In 1891 he began a series of more than 2,500 successful glider flights that proved the value of this innovation. By shifting his body weight, Lilienthal was also able to achieve a degree of directional control. It was insufficient, however, to compensate for sharp gusts of wind such as the one that caused his glider to stall and sent him plummeting to his death in 1896.

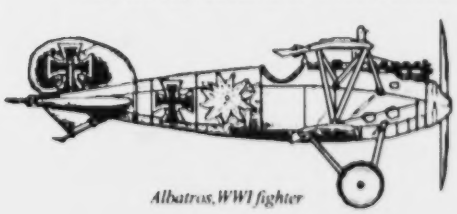
Although many experimenters around the world studied and improved on Cayley's and Lilienthal's work as the 19th century drew to a close, most were unable to overcome the two main obstacles to creating what would be called an "airplane"—a suitable source of power and an effective means of directional control.

Orville and Wilbur Wright, with their famous flights at Kitty Hawk, North Carolina, were the first to solve these problems. The Wright brothers had long been interested in flight and began experimenting with gliders in 1900. They improved the design of the wing to allow more directional control through a process known as warping. The brothers had noticed that when birds flew, they twisted the back edge of one wing upward and the back edge of the other wing downward to change their direction. The Wrights incorporated this feature into their glider design by attaching cords to the wing tips so that they could be warped. In 1902 they flew a glider with this feature successfully at Kitty Hawk, a location they had chosen for their experiments due to its favorable winds. This glider also had an elevator and a rudder to control up-and-down and side-to-side motion, respectively.

Wright Flyer, 1903

A year later, the Wrights returned to Kitty Hawk with their newest machine, the Flyer. It had the same basic design as their 1902 glider, with the addition of an engine and propellers. On December 17, 1903, the Wright brothers made the first controlled, manned, powered, heavier-than-air flights in history. The first of these flights lasted 12 seconds and traveled 120 feet. The impact of their success, however, was not felt until 1908, when the Wrights demonstrated their achievements in the U.S. and France.

The next year, 1909, was a significant year in aviation history. Louis Bleriot flew his monoplane across the English Channel from France to England, becoming the first person to fly an airplane across a body of water or from one country to another. Also in France, Elise Deroche, also known as "La Baronne de La Roche," became the first licensed woman pilot. In that same year, the first U.S. Army airplane was built by the Wright brothers. Two years later Glenn Curtiss, the father of naval aviation, flew his first successful seaplane in San Diego.



Albatros, WWI fighter

World War I spurred great advances in aviation use and technology. At the beginning of the war, airplanes were used primarily for observation. With the addition of machine guns,

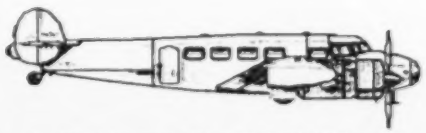
however, airplanes became effective weapons of war. Design innovations also made planes larger, faster, and capable of carrying bombs.

Curtiss Jenny, 1918 mail plane

In May 1918, the U.S. became the first country to offer regularly scheduled, year-round airmail service. The first route ran between Washington, D.C., and New York City. After the war ended in November 1918, the Post Office used many surplus Army aircraft and a smaller number of new planes to expand airmail service across the country.

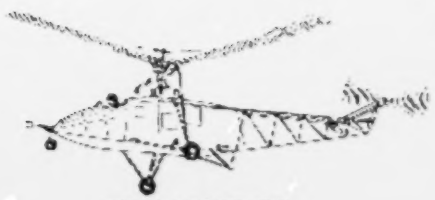
In 1927, Charles Lindbergh won a $25,000 prize, offered in 1919 by hotel owner Raymond Orteig, for accomplishing the first non-stop flight from New York to Paris. Lindbergh left New York on May 20, 1927, in his San Diego-built plane the *Spirit of St. Louis* and landed in Paris 33 hours and 30 minutes later. His solo flight made him a hero overnight and inspired aviation enthusiasts around the world.

Another famous pilot of the inter-war period, Amelia Earhart, also reached legendary status. In 1932, Earhart became the first woman pilot to cross the Atlantic alone. Most people remember her, however, because of her disappearance in 1937. Earhart and her navigator set out from Miami intending to fly around the world, but they were last heard from over the Pacific Ocean. Many theories for their disappearance exist, but all searches either then or since have failed to find any evidence of the airplane or its crew.



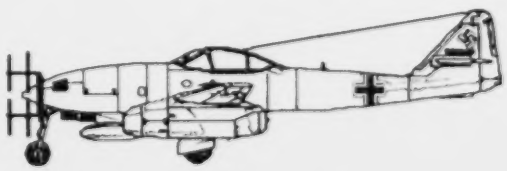
Lockheed Electra similar to Earhart's 1937 model

Around the time of Earhart's last flight, a man named Igor Sikorsky was working to improve another type of aircraft, the helicopter. Documents relating to the theory and design of helicopters date as far back as the fourth century, and in addition to his ornithopter, da Vinci had sketched a helicopter-like "helical air screw." In 1907, a helicopter achieved flight at about 5 feet, but it was practically uncontrollable. Sikorsky and his aircraft company perfected the single-main-rotor helicopter in the late 1930s, and the following decades brought significant improvements in performance and reliability. Helicopters are now widely used for military, emergency-rescue, and commercial purposes.



Sikorsky's VS 300, 1939

Airplanes played an important role in World War II. During this period, aviation technology again saw many advances, the most significant being the development of jet aircraft. Experiments with jet propulsion had been conducted as early as 1910, but war demands accelerated the progress being made in this area. German engineers were the first to produce an operational jet fighter, the Messerschmitt 262. Although Great Britain and the U.S. also developed jets during the war, they did not see combat; the first jet-to-jet aerial engagement did not occur until the Korean War (1950).



Messerschmitt 262

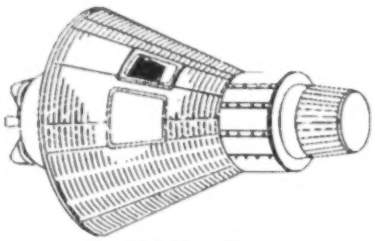
It was longer still before jets were used in commercial aviation. Great Britain's de Havilland Company developed the Comet jetliner in 1952, but withdrew them from service after two disastrous crashes. The

Boeing 707

problems were solved and Comets returned to transatlantic jet service in 1958, about the same time as America's Boeing 707.

Space flight had been a human dream for centuries, but in the years following World War II that dream became a reality. The Cold War between the United States and the Soviet Union motivated each to devote tremendous resources to the space race. The Soviets led with the launch of their *Sputnik* satellite on October 4, 1957, and Soviet Cosmonaut Yuri Gagarin became the first man in space on April 12, 1961.

The United States was not far behind. Projects Mercury, Gemini, and Apollo put Americans into space, into orbit, and on the moon during the 1960s. The first American in space, Alan Shepard, flew a 15-minute sub-orbital mission in a Mercury capsule on May 5, 1961. In February 1962, John Glenn was the first American to orbit the earth. In 1965, the Gemini program, with its two-man space craft, began a series of missions to perfect the skills needed to reach the moon.

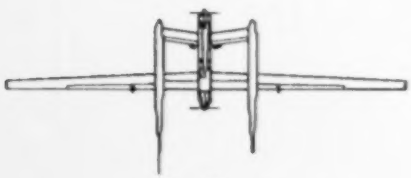


Gemini capsule

The Apollo program received a serious setback when three astronauts perished from a fire in their command module during ground testing in January 1967. In July of 1969, however, the Apollo 11 mission fulfilled President Kennedy's 1961 goal of landing on the moon before the close of the decade when Neil Armstrong, followed shortly by Buzz Aldrin, stepped onto the lunar surface.

During the 1970s, the National Aeronautics and Space Administration (NASA) began developing the Space Transportation System, or Space Shuttle. The first STS mission launched on April 12, 1981. After two days in orbit, Commander John Young and Pilot Robert Crippen safely landed the shuttle *Columbia*. Although grounded for two and a half years after the tragic loss of *Challenger* and its crew in 1986, the Space Shuttle will continue as America's primary space vehicle into the 21st century.

Since the end of the Cold War, the U.S., the former Soviet Union and other countries have been working together to advance space exploration, with the primary goal of establishing an international space station. Progress in aviation continues as well. In 1986, Dick Rutan and Jeanna Yeager became the first people to fly non-stop around the world without refueling in their sophisticated aircraft, *Voyager*. These examples demonstrate how aerospace technology continues to progress as the 21st century approaches.

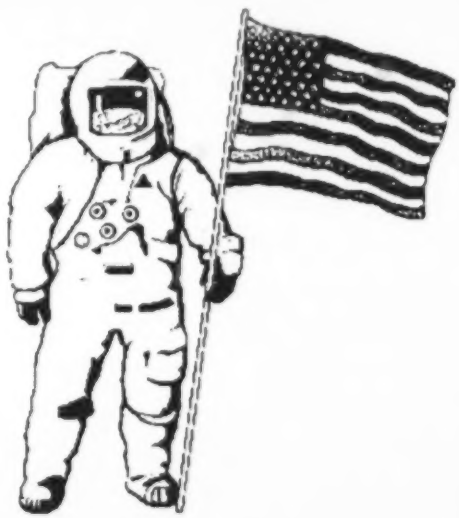


Rutan Voyager

San Diego Aerospace Museum
Education Department
2001 Pan American Plaza
Balboa Park
San Diego, CA 92101-1636
(610) 234-8291, ext.19 (619) 233-4526 Fax

FLYING ABCs

Number each set of words in abc order:

Earhart		balloon
Lindbergh		glider
Wright		space shuttle
Curtiss		airplane
Lilienthal		dirigible
Montgolfier		jet
Icarus		ornithopter
Zeppelin		monoplane
Sikorsky		biplane
Yeager		helicopter

Make a sentence by putting the words in abc order.

1. can float balloon a miles many

_____

_____

2. no has glider a power

_____

_____

3. hovers one helicopter a in spot

_____

_____

FLIGHTS OF FACT AND FANCY

PURPOSE Students develop appreciation for poetry, review information about aviation history and look at flight from an impressionistic, romantic and historical standpoint.

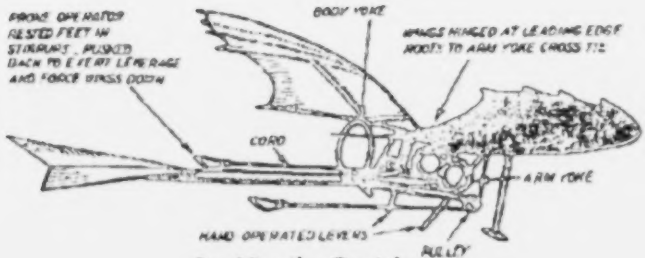
TASK Students read poetry related to flight and compose their own poems (or younger students might draw a picture relating to a poem).

SUPPLIES Reference materials, poetry books, paper, pencils, art supplies.

PROCEDURE

1. Have each student find a poem that deals with some aspect of flight (e.g., impressions and feelings about flying, bird flight, kite-flying, airplane flight). Some examples by famous poets appear on the following pages.
2. Have each student read the selections aloud to the class after practicing independently.
3. Lead a discussion about the different styles of poetry and how some of the elements of these poetic styles are represented in the poems students have been reading (e.g., narrative, haiku, rhyme, meter, repetition).
4. Have each student select a poetry form, then write a poem related to flight or flight history in that poetry form. Supply a few lines for inspiration, if appropriate.
5. Have the students read their own poems aloud to the class.
6. Have each student make a poster to illustrate his or her poem. The posters may be displayed on a bulletin board.

OPTIONAL Help the students compile a book of their own poetry on flight, design the front and back covers and then bind the book.



Da Vinci's Ornithopter

San Diego Aerospace Museum
http://www.aerospacemuseum.org

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POEMS

Wilbur Wright and Orville Wright

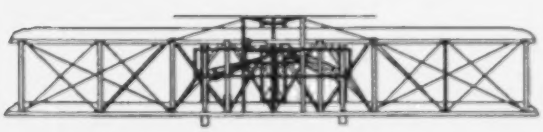
Said Orville Wright to Wilbur Wright,
"These birds are very trying.
I'm sick of hearing them cheep-cheep
About the fun of flying.
A bird has feathers, it is true.
That much I freely grant.
But must that stop us, W?"
Said Wilbur Wright, "It shan't."

And so they built a glider, first,
And then they built another.
—There never were two brothers more
Devoted to each other.
They ran a dusty little shop
For bicycle-repairing,
And bought each other soda-pop
And praised each other's daring.

They glided here, they glided there,
They sometimes skinned their noses.
—For learning how to rule the air
Was not a bed of roses—
But each would murmur, afterward,
While patching up his bro.
"Are we discouraged, W?"
"Of course we are not, O!"

And finally, at Kitty Hawk
In Nineteen-Three (let's cheer it!),
The first real airplane really flew
With Orville there to steer it!
—And kingdoms may forget their kings
And dogs forget their bites,
But not till Man forgets his wings
Will men forget the Wrights.

Stephen Vincent Benet



Wright Flyer, 1903

Charles Lindbergh's Spirit of St. Louis, 1927

Lindbergh

He was just a young aviator, and his nerves they
were steady and true,
He took many chances and won them, so they
called him the "Flying Fool."
He said, to his friends, "I've a notion to pilot a
trail o'er the sea,
I'll fly like a bird o'er the ocean, adventure is
calling to me."
O'er the sea, o'er the sea like an eagle, alone he
was making his flight,
And his loved ones behind him were praying for
the Lord to protect him that night.

Alone in his airplane he speeded; he thought of his
mother at home;
She gave him the courage he needed to fly 'neath
the sky's starry dome.
Into the darkness he hurried, he passed through
the sleet and the rain,
But this young human bird wasn't worried, his
heart had a goal to obtain.
O'er the sea, o'er the sea like an eagle, there was
no one to give him the cheer,
But he knew, as his eyes pierced the distance, that
the goal he was seeking was near.

Thousands were waiting in Paris to see the young
pilot alight.
The cheers reached the sky when they saw him
come flying out of the night.
The news was sent back to his loved ones, the
whole world was crazy with joy,
They acclaimed him the bravest of flyers, this
darling young slip of a boy.
O'er the sea, o'er the sea like an eagle, he had
answered adventure's great call,
And his name will go down through the ages, as the
bravest hero of them all.

Clyde Spencer

Courage

Courage is the price that life exacts for granting
peace.
The soul that knows it not, knows no release
From little things;

Knows not the livid loneliness of fear
Nor mountain heights, where bitter joy can hear
The sound of wings.

How can life grant us boon of living, compensate
For dull gray ugliness and pregnant hate
Unless we dare

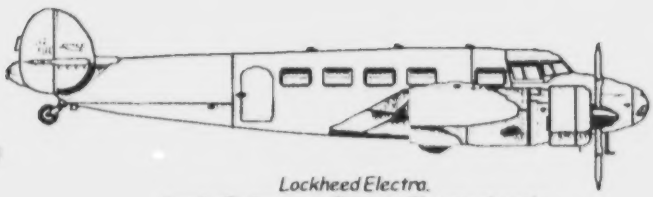
The soul's dominion? Each time we make a choice, we
pay
With courage to behold resistless day
And count it fair.

Amelia Earhart

Wingtip

The birds—are they worth remembering?
Is flight a wonder and one wingtip a marvel?
When will man know what birds know?

Carl Sandburg



Lockheed Electra.
Amelia Earhart was flying an Electra when she disappeared in 1937.

Amelia Earhart's Last Flight

1. Like a ship out o'er the ocean
Like a speck against the sky
Amelia Earhart flying past that day,
With her partner, Captain Noonan
On the second of July
Her plane fell in the ocean far away.

2. Half an hour later
An SOS was heard
Her signal weak, but still her voice
was brave.
In shark-infested waters
Her plane went down that night
In the blue Pacific to a watery
grave.

3. Now you have heard the story
Of that awful tragedy
We pray that she may fly home safe
again.
In days to come though others
Blaze a trail across the sea
We'll ne'er forget Amelia and her
plane.

Chorus:
There's a beautiful, beautiful field,
Far away in a land that is fair,
Happy landings to you, Amelia
Earhart,
Farewell First Lady of the air.

David McNery

SOMETHING'S WRONG

The *information* in the sentences below is correct, but can you find the mistakes in grammar, punctuation, and sentence structure? Rewrite each sentence correctly.

1. Chuck Yeager flew the first supersonic flight, in 1947.

Yeager's Bell X-1

2. There wasn't no one that had flown from New York to Paris before Charles Lindbergh.

3. Amelia Earhart was a great pilot she was the first woman to fly solo across the Atlantic Ocean.

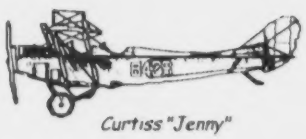
4. The Wright Brothers was the first people to make a controlled, powered flight in an airplane.

Wright Flyer

5. A Piper Cub has two seats, so you and me could both ride in it.

6. The Curtiss "Jenny" was a plane people delivered mail with.

7. Neil Armstrong on the moon in 1969.



Curtiss "Jenny"

AERIAL JUMBLE

Put the words in order to make sentences about the history of flight.

1. machines balloons were the first flying

2. largest the built Hindenburg was the Zeppelin

3. Shuttle the liftoff during Space exploded *Challenger*

4. successful airplane Kitty Hawk made Wright Brothers the first the flight at powerdriven

5. from solo made Lindbergh to first flight nonstop New York the Paris

6. to fly across solo the first Amelia Earhart woman was the Atlantic

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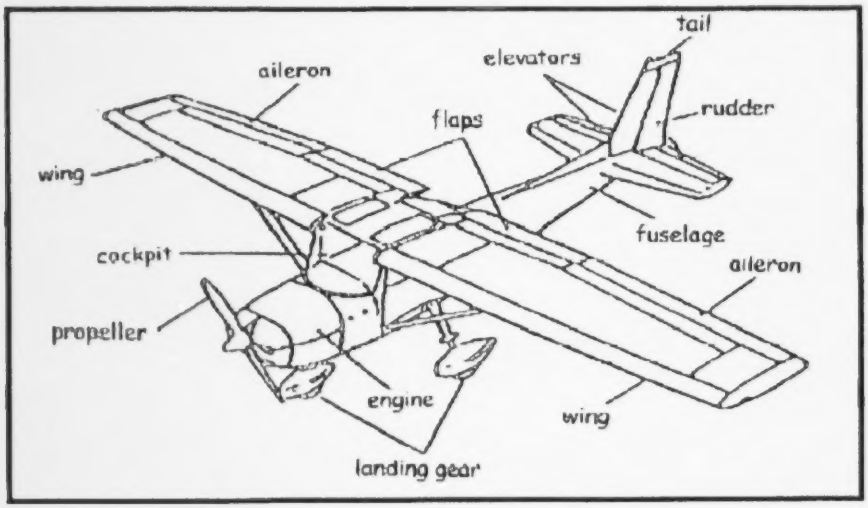
SCRAMBLED

Study the labeled drawing of the airplane and its parts. Unscramble these words that are related to an airplane.



1) sgniw	dedrur	useeflag
_____	_____	_____
2) potckic	lorepplер	tolip
_____	_____	_____
3) lanieros	slafp	dinglan egra
_____	_____	_____
4) eelavort	gennie	lait
_____	_____	_____

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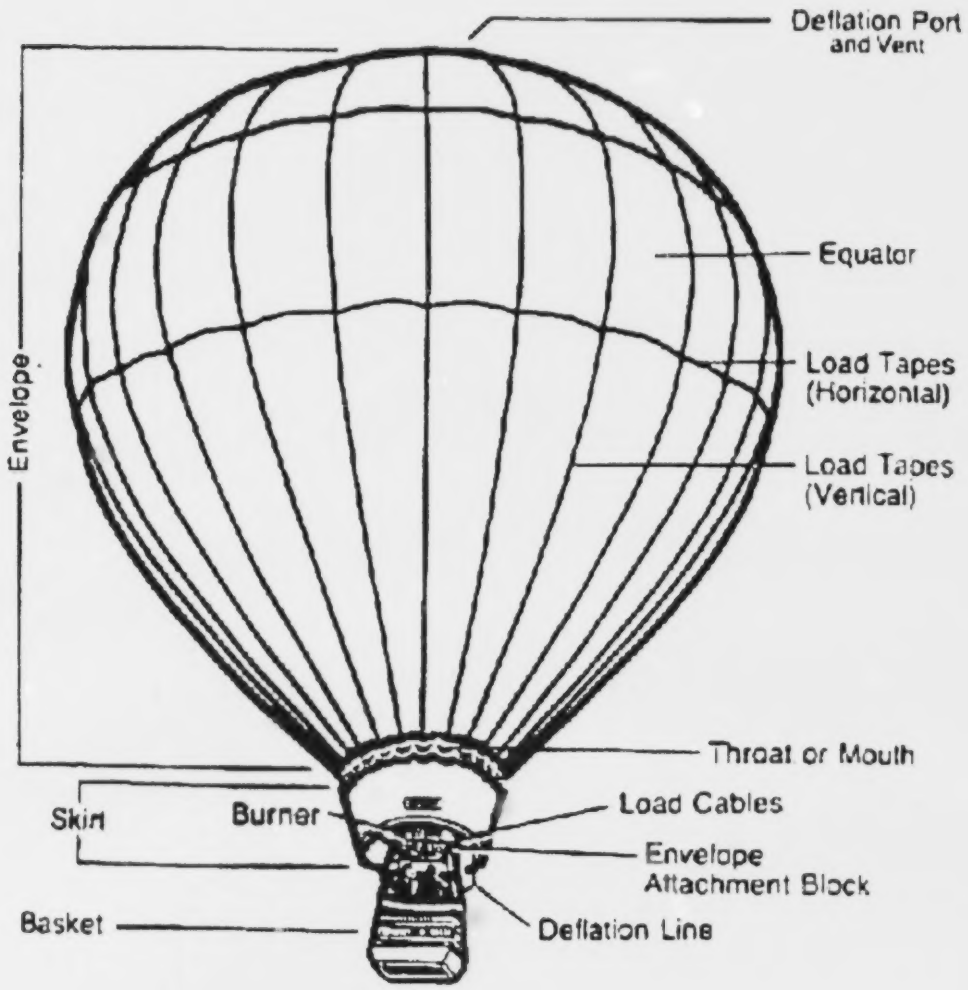
Balloon Scramble

Use the labeled drawing of the hot air balloon to help you unscramble the words below.



vleeneop	nedfatlio nile	rubren
_____	_____	_____
triks	oald scabel	doal spate (trevilac)
_____	_____	_____
troath ro thoum	tequaro	adol epsat (zhortinalo)
_____	_____	_____
fladenoti torp dna tenv	vleeneop ttaachtmen cklob	sketab
_____	_____	_____

"In Aviation News . . ."

PURPOSE

Students experience aviation history firsthand, practice writing skills, do a little acting, and have a lot of fun!

TASK

The class, working in small groups compiles a news program that covers a year in aviation history.

SUPPLI ES

Reference materials, writing supplies, art supplies for visuals and to make costumes, video camera and television (if news won't be "broadcast" live).

PROCEDURE

1. Introduce students to the history of aviation (if students are older, have them do a little research on important people or events in aviation history, then have them present their findings to the class).

2. As a class, pick the year (or decade) you want to focus on in your news program.

3. Discuss television news programs. How long are they? What topics do they cover? How do they present their information? Brainstorm the elements of a news show (e.g., "headline" items, human interest stories, sports, weather, entertainment, and--of course--commercials). If possible, watch part of a local newscast and identify its parts. Split the class into groups of two or three and either assign or let each group choose what segment of the show they will be responsible for. Tell each group they will have to fill (and not overfill) a certain amount of time, to be determined by how long you want the whole program to be.

4. Take a trip to the school library and have students research to find information for their segment. Make sure they stick to events that happened in the year or decade your news program will focus on.

5. Over the next week or so, give students time in class to research and write their segment. Have them write a script and practice presenting it. Also have them begin collecting and bringing in materials they and other students will use during the broadcast (someone may need to be assigned to be the propmaster--someone who can make sure props and costumes look authentic for the period or year your news program is from--this will require some research into fashion). They should also create any visual aids they want to use. Don't forget a logo for the program!

6. Before the broadcast, have the class determine the order in which their segments will be presented. Write this order down and remind students of their time limits. As the "director," you will let them know if their time runs out. If the news is "live," tell them they must stick to their script and the schedule. If the broadcast is going to be recorded one segment at a time, you might allow everyone two takes. (Another option is to let students tape their segments outside of class and have someone edit them all together into one show.)

7. Broadcast your news. Have an in-class rehearsal of the program so students can enjoy their classmates' efforts, then take your show on the road to another class so these aviation experts can share their knowledge with others. (It might be fun to present the show for parents as well.) If the program is "pre-recorded," present the finished project to your class, then share it with others.

TIPS:

- If students are struggling for topics, remind them that interviews are always good.
- Rather than just focusing on one topic, each group should cover several items, spending only a minute or so on each.
- Remind students that the news broadcast is taking place during the year they have chosen. Students should dress, speak, and behave accordingly!
- If students point out that TV didn't exist during the year you've chosen, discuss movie newsreels and radio news programs. If you want to be truly authentic, you could forgo the broadcast altogether and publish an aviation newspaper instead. In this case, segments would become articles and students would be reporters rather than anchors and actors. "Publish" your newpaper and distribute it around the school.
- Instead of aviation news, a class could focus on a year in spaceflight history. Or, instead of focusing on history, students could use their imaginations to create a futuristic broadcast of "Aviation 2010" or "Space 2050."

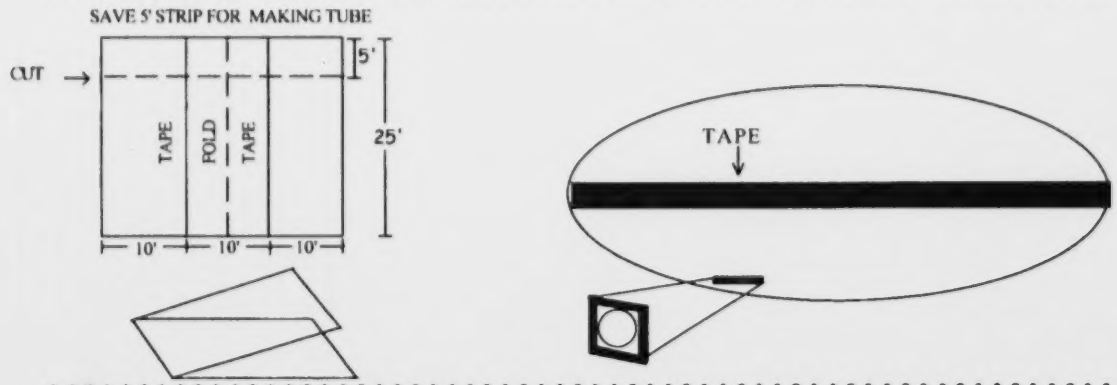
THE BUBBLE CLASSROOM

PURPOSE To transform the classroom into a unique and memorable environment for learning about aviation.

SUPPLIES
4mm clear polyethylene sheeting (These plans use 3 rows 10' x 25'.)
2" duct tape (at least 60 yards)
window fan (2 speeds, if possible)
old blankets or bedspreads (to be placed under the bubble if the floor isn't carpeted)
carpet pieces, foam, or blankets (for students to sit on inside the bubble)

PROCEDURE The blown-up bubble will measure about 20' x 15' x 7' and will hold about 40 people. You may need to adjust the size of the bubble so that it will fit your classroom. Assembly requires approximately one hour. If possible, allow the students to help.

1. Tape plastic together as indicated, cut as indicated, and fold as shown.
2. After folding, tape 3 edges together to make a large pillow.
3. Make a tube out of the remaining plastic that will be large enough to go around the outside of the fan. The tube can be any length, but keep in mind the size of the classroom.
4. Cut a slit horizontally in the side of the bubble near the bottom. Tape the fan tube to the bubble, then tape the other end of the tube to the fan. Any side of the bubble can be used.
5. Make a slit for the door. Do this by starting the fan at high speed, allowing the bubble to inflate (this should take about 2-3 minutes). When the bubble is almost fully inflated, turn the fan to low speed, cut the slit for the door (make sure it's large enough for the tallest person to enter), then reinforce the slit by taping the edges. Note: The fan should remain on at all times.



The bubble is now ready for use! The possibilities are endless, but here are a few suggestions for how to use the bubble as an effective tool:

- Discuss air. Point out that air takes up space and exerts pressure by explaining how the bubble inflates and stays inflated. For further illustration, students can blow bubbles inside the bubble!
- Talk about space stations. Have students imagine what a space colony would look like, then have them write stories about or draw pictures of their ideas.
- Do some of the other activities discussed in this packet inside the bubble.

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AIRMAIL!

PURPOSE Students learn the importance of airmail in the history of aviation.

TASK Students design airmail stamps and operate their own airmail service.

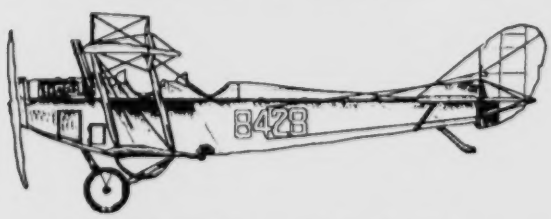
SUPPLIES Art supplies, 9-inch x 12-inch construction paper, large cardboard boxes, samples of real airmail stamps, slides and photos about airmail.

PROCEDURE

1. Initiate a class discussion to determine what the students already know about airmail. Supplement their knowledge with additional information about the development of airmail service. Between World Wars I and II, for example, the emphasis in the field of aviation was on barnstorming, air racing, carrying passengers and carrying mail.
2. Have students examine real airmail stamps from around the world and identify the basic elements that make up a stamp. Explain that in the United States so much mail travels by plane that a special airmail stamp is no longer used for domestic mail.
3. Have each student design an original stamp that features a significant aviation figure or event. Originals can be displayed on a bulletin board.
4. Have students reduce the original designs to postage-stamp size. These stamps can then be grouped on a single sheet of paper and duplicated.
5. Have students set up a classroom post office, using play money to buy stamps for use in the optional letter-writing activity below and for depositing letters in a cardboard mailbox.
6. Have some students act as postal workers and sort the mail and other students act as pilots delivering the mail.

OPTIONAL

1. Encourage letter writing between students in two or more classes with students role playing.
2. Suggest ways in which the students can develop their airmail system so that it parallels the historical development of airmail service in the United States and internationally.
3. Have students build a cardboard airmail plane into which two students and the mail can fit. Select two students to be airmail pilots responsible for delivering the letters.



A Curtiss JN-4, the first U.S. airmail plane

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AIRPORT MATH

1. If a round trip ticket from San Diego to Minneapolis costs $325.00, how much would you have to pay for two tickets?

---

2. A jet left San Diego with 155 passengers. At Denver 34 passengers deplaned and 45 boarded. How many passengers are on the jet now?

---

3. Your plane left Seattle at 9:30 a.m. You arrived in San Diego at 11:45 a.m. How long did your flight take?

---

4. There are five airplanes waiting to take off from a San Diego airport. Three of them are twin engine aircraft. The other two are single engine aircraft. How many engines are there on all five airplanes?

---

5. A jet is ready to take off. In the cockpit are the pilot, co-pilot, and flight engineer. There are two flight attendants in the first class section and four flight attendants in the coach section. How many crew members are there?

---

6. Your class is going for an airplane ride over San Diego. The teacher's ticket costs $20.00. Each student ticket costs 1/2 of the teacher's ticket. How much will it cost for the entire class to go on this ride?

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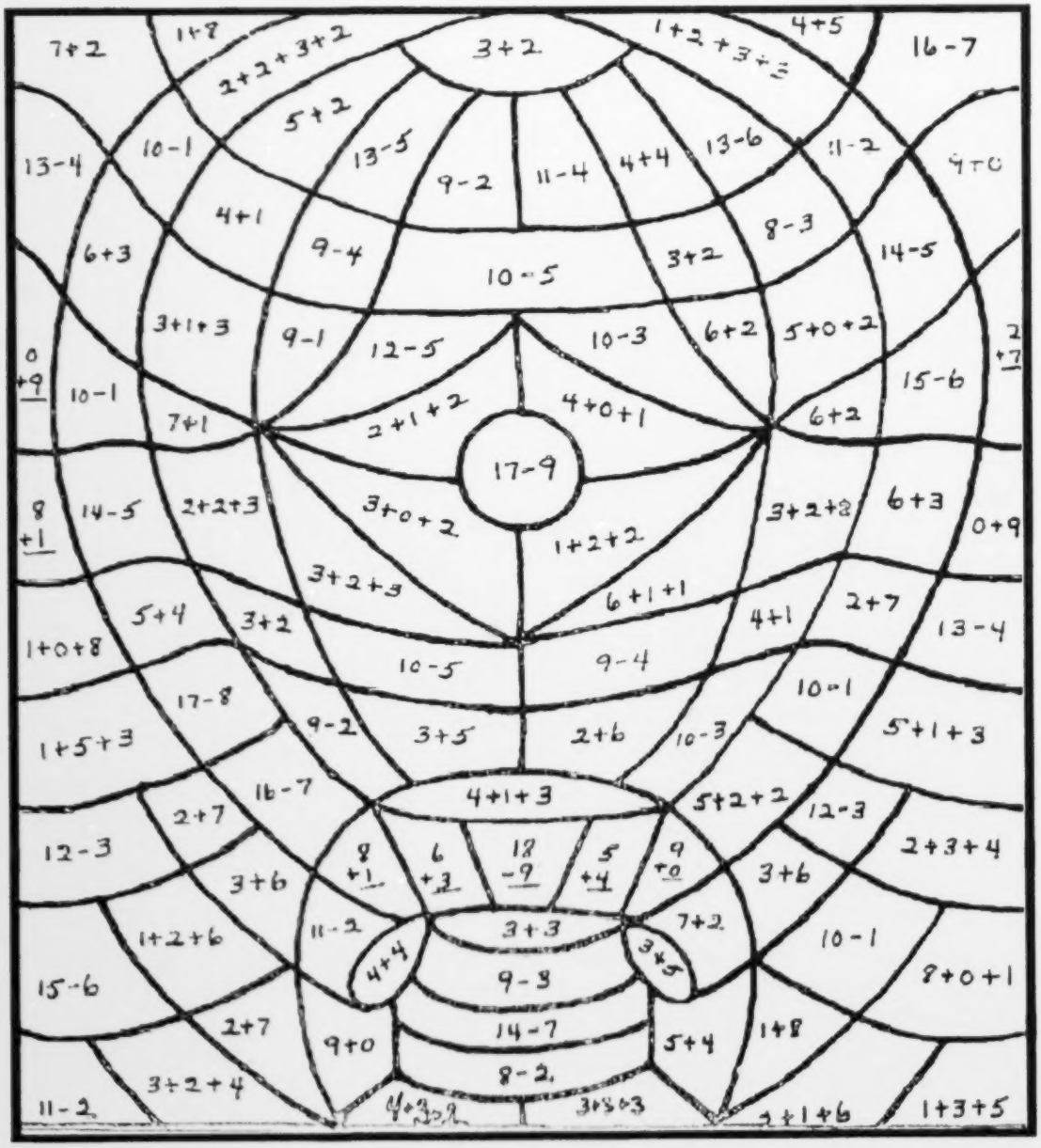
UP, UP, AND AWAY!

Find the answers to the problems, then color the spaces according to the key below to reveal the hidden picture!

Key:	5—red	8—yellow
	6—brown	9—blue
	7—green	



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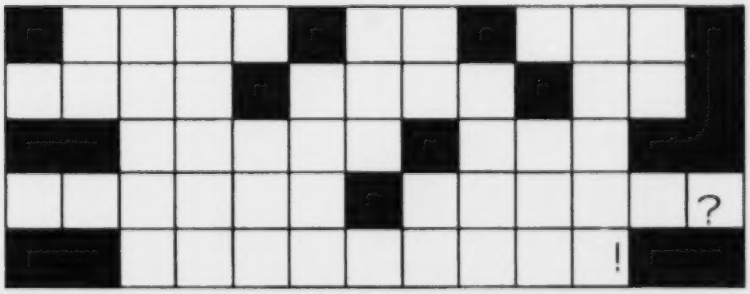
Kite Wordsearch

DRAG
FLIGHT
GRAVITY
KITE
LIFT
SOAR
STRING
TAIL
THRUST
WIND

Y G I M Q E G G S B V Z B T R
S N W C U R P T N F B B Y G J
I Y F G A V B O H I L G A I G
R B A V M D I O U D R I U W W
Z R I I I S F K I T E T F N C
D T L A H S J C T O F V S T A
Y Q P W L V X U T A C Y D V I
T N H B E L D D K R X Q T O S
D X T I W I K U E U G B D U Z
Y M S U U E F X Z A J P U I P
S D U M S U S Z Z J O S Y H R
X A R N U T O E O C U M A R G
O O H W A I A P A K R D V R T
L T T I H F R H D E K X F L F
T V L D N I W G W T H G I L F

These letters have fallen out of their boxes- put them back and read the riddle



H A T K I T
S T P E I S D O H
W P A N G R N F T O E
B E K I Y P A K I R R F
M A F L P E E S

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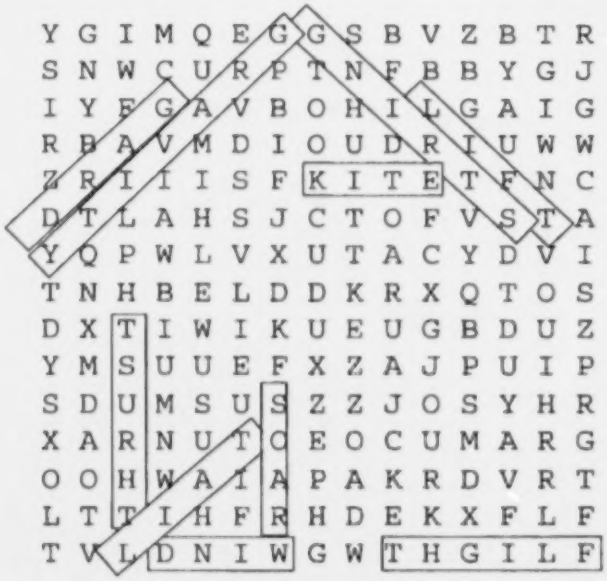
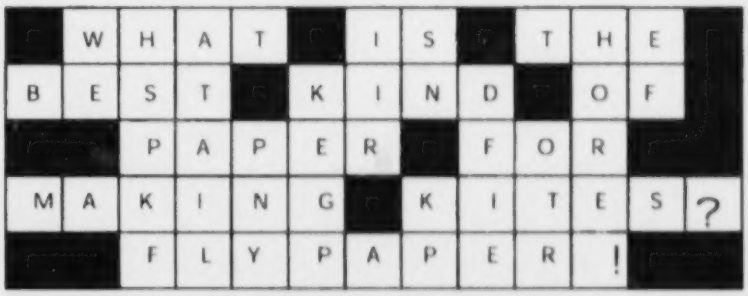
Kite Wordsearch

DRAG
FLIGHT
GRAVITY
KITE
LIFT
SOAR
STRING
TAIL
THRUST
WIND


Y G I M Q E G G S B V Z B T R
S N W C U R P T N F B B Y G J
I Y F G A V B O H I L G A I G
R B A V M D I O U D R I U W W
Z R I I I S F K I T E T F N C
D T L A H S J C T O F V S T A
Y Q P W L V X U T A C Y D V I
T N H B E L D D K R X Q T O S
D X T I W I K U E U G B D U Z
Y M S U U E F X Z A J P U I P
S D U M S U S Z Z J O S Y H R
X A R N U T C E O C U M A R G
O O H W A I A P A K R D V R T
L T T I H F R H D E K X F L F
T V L D N I W G W T H G I L F



H A T K ! T
S T P E I S D O H
W P A N G R N F T O E
B E K I Y P A K I R R F
M A F L P E E S

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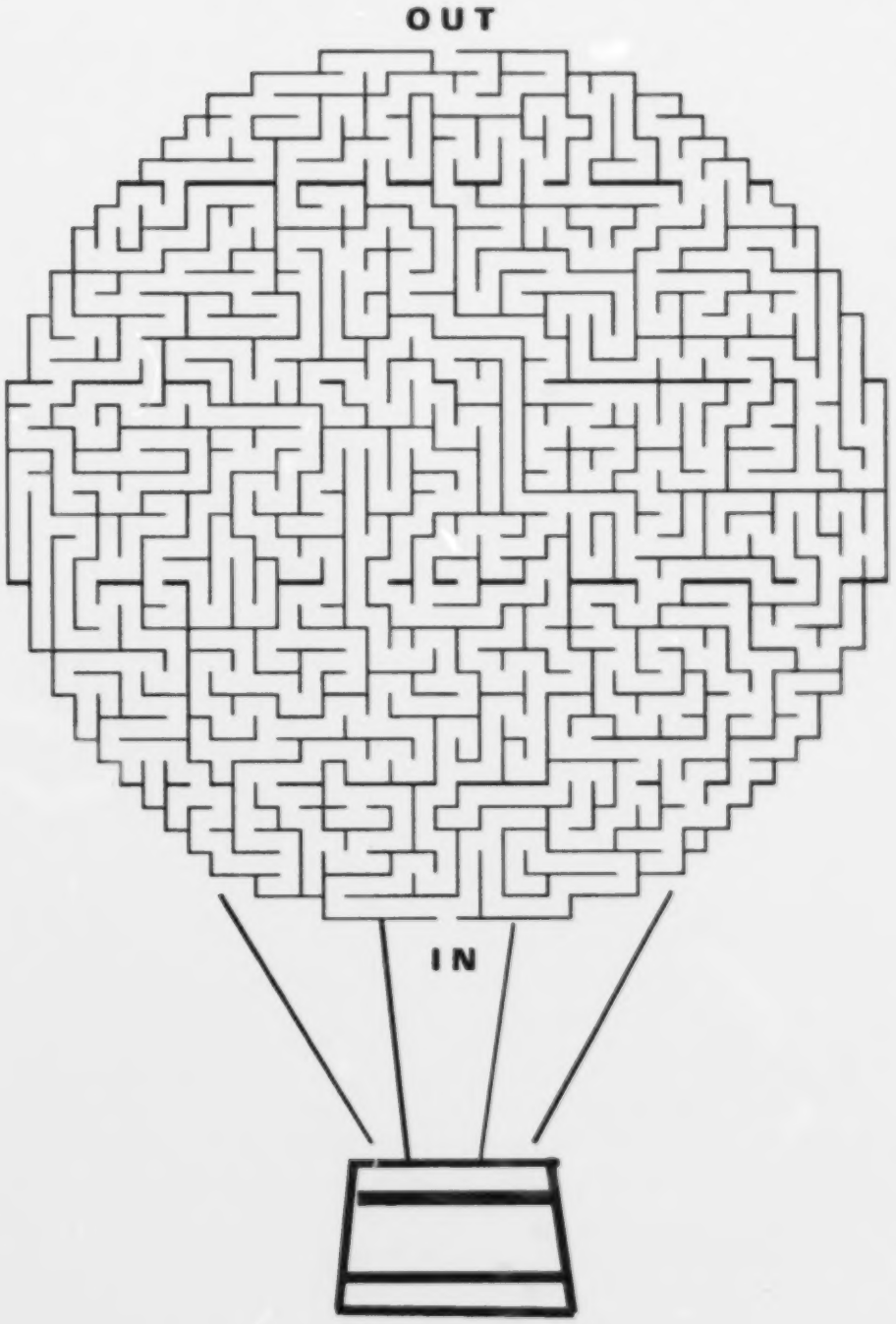
Help the air find its way through the balloon!



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Hot Air Balloon Word Scramble

Unscramble the words. For the answer to the riddle, copy the letters from the numbered squares to the squares below.

LONOLBA

LAHCUN

DELTAEF

NILTEFA

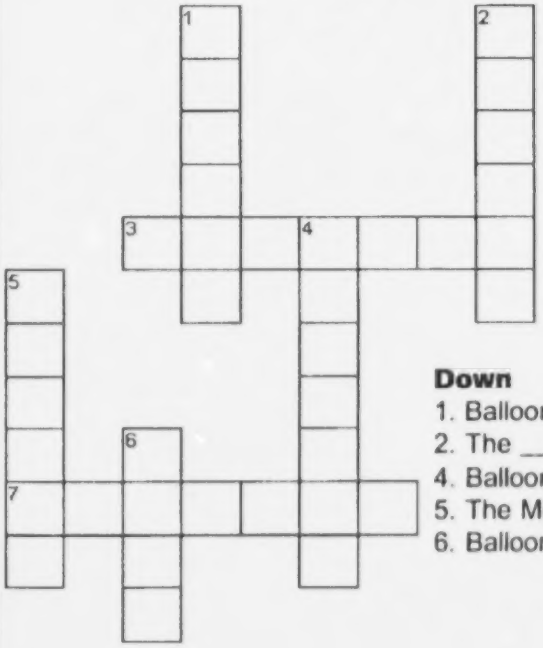
NIWD

RETNOAUA

What did the hot air balloon say to the pin?

1 2 3 1 4 5 6 7 8 S 9 10 5 !

Hot Air Balloon Crossword



Across

3. Before you pack it up, you have to _____the balloon
7. A duck, sheep, and a_____ were the first hot air balloon passengers

Down

1. Balloon passengers ride in a _____
2. The _____heats up the air in the balloon
4. Ballooning is a type of _____ than air travel
5. The Montgolfier brothers lived in _____
6. Balloons go whichever way the_____ blows

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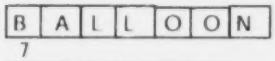
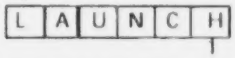
Unscramble the words. For the answer to the riddle, copy the letters from the numbered squares to the squares below.

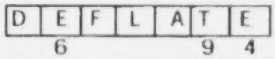
LONOLBA



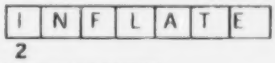
LAHCUN



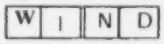
DELTAEF



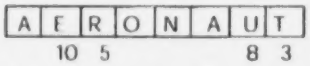
NILTEFA



NIWD



RETNOAUA



What did the hot air balloon say to the pin?

Hot Air Balloon Crossword

Across

3. Before you pack it up, you have to _____ the balloon
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Down

1. Balloon passengers ride in a _____
2. The _____ heats up the air in the balloon
4. Ballooning is a type of _____ than air travel
5. The Montgolfier brothers lived in _____
6. Balloons go whichever way the _____ blows

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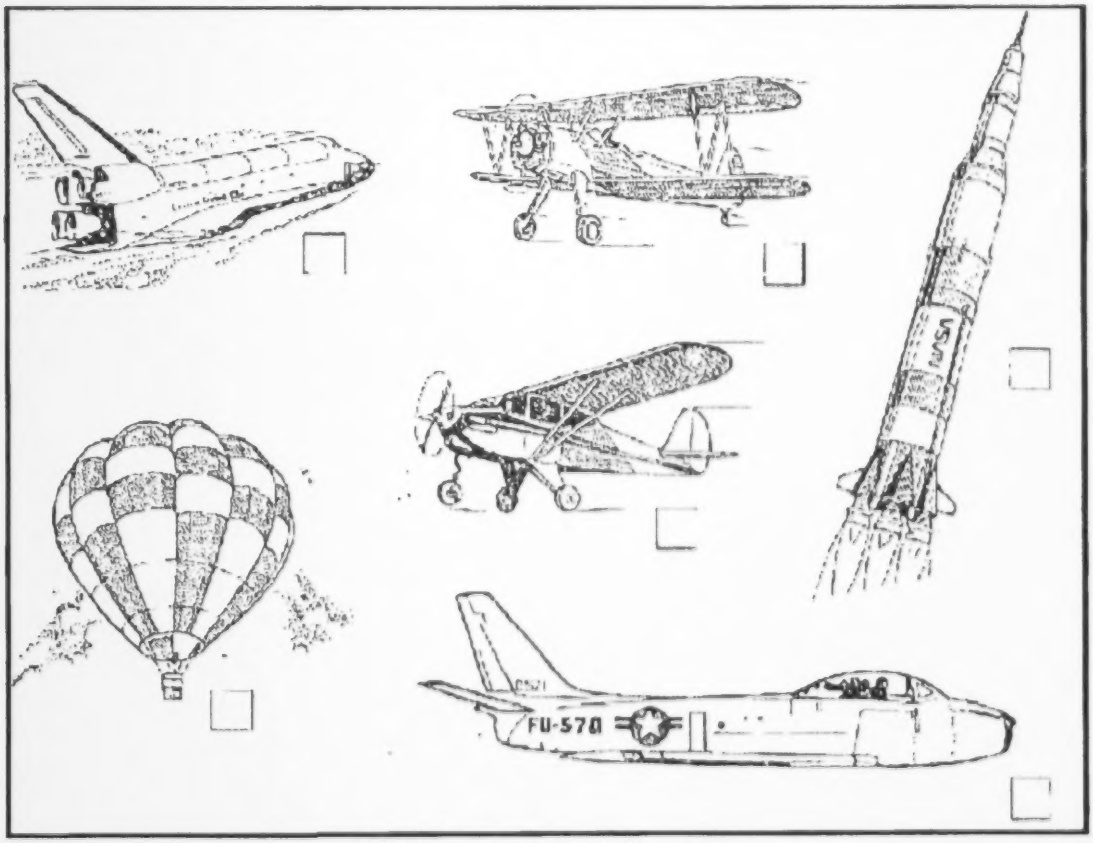
FLYING MATCH

Match the number from the sentence to the correct picture.

1. A *monoplane* is an airplane with one set of wings.
2. Some *balloons* are filled with hot air.
3. A *jet airplane* does not have a propeller.
4. A *biplane* is an airplane with two sets of wings.
5. A *rocket* lifts things into space.
6. The *space shuttle* carries people into space and returns them to Earth.



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